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ABSTRACT

Based on the broader needs for long-term studies of the effects of instructional treatments, for behavioral objectives, and for learning hierarchies, this research investigated differences in the effect on learning and rate of forgetting when students are informed of the behavioral objectives and learning hierarchy. It was expected that students who were informed of the behavioral objectives of an activity would perform higher on achievement and retention posttests. Nine null hypotheses were tested, using 88 elementary education majors divided into four groups. Students were classified according to their ability levels and each group received different information concerning the use of the self-instructional text material. Posttests were administered immediately on completion of the unit to compare the degree of learning, and after 2 weeks to compare the rate of forgetting. Analysis of variance was used in evaluating the data, and results showed that of the nine hypotheses formulated, the data supported two--that the four treatments result in different rates of forgetting, and that the differences in over-all performance scores resulting from the four treatments are not identically reflected at each ability level. A further study is being prepared in a typical classroom situation without the use of self-instructional materials. (MBM)

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BEHAVIORAL OBJECTIVES

AND

RATE OF FORGETTING

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BEHAVIORAL OBJECTIVES AND RATE OF FORGETTING*

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Introduction

A principal goal of the curriculum-reform movement is increased learning and retention. There have been many research studies conducted to determine the effects of various manipulative variables on learning and retention. Many of these studies have contrasted the effect on achievement and retention of different classroom materials and different methods of instructing the student in the classroom. Although such efforts have been extensive, in a recent journal article entitled "On the Assessment of Retention Effects in Educational Experiments" Kenneth H. Wodtke (1) of The Pennsylvania

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State University made a plea for an even greater emphasis on long-term follow-up measures in studies of the effects of instructional treatments. He argued that there is a need for the investigation of instructional treatments specifically designed to facilitate such long-term effects. He pointed out that, even though some instructional variations might be of little value in facilitating the amount of learning, these same variations might have their primary effects on long-term retention. That is, an instructional treatment might produce relatively inefficient learning, but greater resistance to forgetting than some other treatments.

Advocates of behavioral objectives for education, such as Gagné (2), Mager (3), Walbesser (4), and Popham (5) have called for more specific statements of purpose and expected outcomes in new curriculum development. The American Association for the Advancement of Science has developed a curriculum entitled Science--A Process Approach (6), in which the objectives of the curriculum are stated in terms of what the student is to do rather than in terms of verbalizable knowledge that the student is to know. Behavioral descriptions of the objectives of curriculum has become basic to some new proposals for curriculum revision and development.

The Teacher Education Project, sponsored by the Division of Elementary and Secondary Education Research,

U.S. Office of Education, is a multi-phase project which has as its objective the production of model programs for the training of elementary school teachers. Nine sets of specifications for elementary teachers education programs were produced in 1968 by nine universities in Phase I of this project. In each set of design specifications, the objectives of the curriculum model were described in behavioral terms. The sponsoring agency expects that the future implementation phase of this project will produce demonstration institutions which will bring about the improvement and updating of elementary education across the country. If the existing model programs produced in Phase I are utilized, a key dimension of the updating of elementary education will be the use of behavioral objectives.

Another dimension of curriculum design which has begun to play an important role in new curriculum developments is the construction of learning hierarchies. Gagné has hypothesized that intellectual skills that are learned

> . . . have an ordered relation to each other, such that subordinate ones contribute positive transfer to superordinate ones [7].

Gagné refers to learning sequences which exhibit such ordered relations between the behavioral objectives as learning hierarchies. There have been several recent researches reported which investigated the problems of

hierarchy construction and behavioral description of learning outcomes. Among the recent contributions to this literature are those by Gagné (8,9), Walbesser (10,11,12), Walbesser and Carter (13), Engel (14), Smith (15), Baker (16), and Cook (17,18,19).

The Question

It is in the context of these three points, 1) need for long-term studies, 2) need for behavioral objectives, and 3) need for learning hierarchies, that a study was conducted by the author to investigate the question:

> If a group of students is informed of the behavioral objectives and the learning hierarchy of a unit of instruction and another group of students receiving the same unit of instruction is not so informed, will there be differences in effect on learning and rate of forgetting?

The study differs from those reported in the literature by the point of emphasis. While utilizing the results of earlier research, the author's research shifts the emphasis from the benefits to be derived from the instructor knowing the objectives and the learning hierarchy to the <u>benefits to be derived from informing the student of the behavioral objectives and the learning hierarchy</u>. It was expected that those students who are informed of the behavioral objectives of an activity will perform higher on achievement and retention posttests than those students who are informed of

the activity's place in a hierarchical learning sequence (designed after Robert Gagné's cumulative learning model) in addition to being informed of the behavioral objectives of the activity will perform higher on achievement and retention posttests than those who are informed just of the behavioral objectives of the activity.

Research Hypothesis

The study was designed to determine whether for a specific population with specific treatments data could be obtained to support the above expectations. Nine null hypotheses related to the following research hypotheses, associated with the initial question and reflecting the stated expectations, were tested by the experiment:

Research Hypothesis 1: Giving students statements of the behavioral objectives (with examples) before each activity of an instructional unit (T_2) results in higher achievement scores for the students so informed than those students who are given no information beyond the actual instruction unit activity (T_1).

Research Hypothesis 2: Giving students copies of the learning hierarchy (with examples) of sequence cells at the beginning and at the end of an instructional unit (T_3) results in higher achievement scores for the students so informed than for those students who are not given any information beyond the actual instructional unit activity (T_1).

Research Hypothesis 3: Giving students statements of the behavioral objectives (with examples) and

copies of the learning sequence before each activity of an instructional unit (T_4) results in higher achievement scores for the students so informed than for those who are not given any information beyond the actual instructional unit activity (T_1).

Research Hypothesis 4: Giving students statements of the behavioral objectives (with examples) and copies of the learning hierarchy before each activity of an instructional unit (T_4) results in higher achievement scores for students so informed than for students who are given only statements of the behavioral objectives (with examples) before each activity of an instructional unit (T_2).

Research Hypothesis 5: Giving students statements of the behavioral objectives (with examples) and the learning hierarchy before each activity of an instructional unit (T_4) results in higher achievement scores for students so informed than for students who are given only copies of the learning hierarchy with examples of sequence cells at the beginning and at the end of an instructional unit (T_3).

Research Hypothesis 6: The differences in achievement scores resulting from the four treatments are not identically reflected at each ability level.

Research Hypothesis 7: The four treatments have differential effects on the over-all performance of students.

Research Hypothesis 8: The four treatments result in different rates of forgetting.

Research Hypothesis 9: The difference in over-all performance scores resulting from the four treatments are not identically reflected at each ability level.

Experimental Procedures

Eighty-eight elementary education majors in a four-year college were blocked on ability levels and randomly assigned to four treatments. While receiving different information about the behavioral objectives and the hierarchical learning sequence, all four groups received the same set of self-instructional text material covering a mathematical unit of instruction.

The subjects were students enrolled in four sections of the second semester of a two-semester sequence mathematics course for elementary education majors at Towson State College, Baltimore, Maryland in the spring of 1969. The students were classified according to their ability levels as reflected by their grades in the first semester of the two-semester sequence course before being randomly assigned to the following four treatments. The first treatment, listed T_1, is the control treatment.

T_1--Self-instructional text material on a mathematical unit.

T_2--Self-instructional text material on a mathematical unit with the objectives given before each activity in the unit.

T_3--Self-instructional text material on a mathematical unit with students informed of the learning hierarchy at the beginning and at the end of the unit.

T_4--Self-instructional text material on a mathematical unit with students informed:

(a) at the beginning of the unit of the learning hierarchy for the instructional unit, and

(b) at the beginning of each activity of the objectives of that activity and of that activity's place in the hierarchical learning sequence.

The self-instructional material for the instructional unit, based upon the learning hierarchy constructed for this study and consisting of eight activities, was administered by the experimentor for eight consecutive class days. After the completion of the instruction unit, posttests were administered immediately to compare the degree of learning, and, after two weeks, to compare the rate of forgetting.

For clarity, henceforth in this paper the following codes will be used for each of the four treatments:

CON for T_1

OBJ for T_2

B-E for T_3

HIER for T_4

Statistical Analysis

This study was designed to investigate several pair-wise comparisons among treatment group means. The nine hypotheses can be grouped into two areas of concern.

The first six hypotheses are concerned with pair-wise comparison of the effects of four instructional treatments on achievement. The last three hypotheses (H_7, H_8, and H_9) are concerned with pair-wise comparison of the effects of the four treatments on retention in terms of over-all performance and rate of forgetting. The treatments by levels analysis of variance was employed to determine whether the data of this study supported the first six hypotheses. An evaluation of the data in terms of the last three hypotheses was made utilizing a repeated measure analysis design (20).

Findings

The findings of this study may be conveniently partitioned into two areas:

1) The effects of treatments on immediate achievement scores obtained on an immediate posttest.

2) The effects of the treatments on over-all performance and rate of forgetting as measured by an immediate posttest and a delayed posttest.

Immediate Achievement

Six null hypotheses concerning immediate achievement and related to the first six research hypotheses were tested using treatments-by-levels analysis of variance. A summary of the results of the treatments-by-levels analysis of

variance (T x L ANOVA) of immediate posttest scores appears in Table I. The F ratio for treatment effect was 0.56, while the critical value of F was 2.78 . Therefore, each of the first five null hypotheses was retained.

TABLE I

TREATMENTS-BY-LEVELS ANALYSIS OF VARIANCE OF IMMEDIATE POSTTEST SCORES

Source of Variation	df	Mean Square	F
Levels of Ability	2	6,503.54	--
Treatments	3	282.09	.56 ns
Interaction (Treatments x Levels)	6	93.28	.19 ns
Within Cells (Error)	76	501.10	

$\alpha = .05$

The F ratio observed for ability-by-treatment interaction effect was 0.19 . The critical value of F at 6,76 df and 0.05 level of significance is 2.27 . Therefore, the null hypothesis for the sixth research hypothesis was retained.

The standard deviations and the cell and marginal means of the four treatment groups on the immediate posttest are reported in Table II.

TABLE II

MEANS, CELL SIZES, AND STANDARD DEVIATIONS
OF IMMEDIATE POSTTEST SCORES

Ability Levels	Treatment: CON	OBJ	B-E	HIER	
High	$\bar{X}_{11}$ = 95.50 n_{11} = 4 SD_{11} = 3.00	86.50 4 17.99	95.00 4 10.00	91.00 4 18.00	$\bar{X}_{1.}$ = 92.00 $n_{1.}$ = 16
Medium	$\bar{X}_{21}$ = 82.00 n_{21} = 9 SD_{21} = 14.11	78.44 9 11.74	74.44 9 23.60	84.56 9 16.85	$\bar{X}_{2.}$ = 79.86 $n_{2.}$ = 36
Low	$\bar{X}_{31}$ = 62.56 n_{31} = 9 SD_{31} = 26.81	53.11 9 31.51	62.00 9 32.44	64.22 9 23.14	$\bar{X}_{3.}$ = 60.47 $n_{3.}$ = 36
	$\bar{X}_{.1}$ = 76.50 $n_{.1}$ = 22	$\bar{X}_{.2}$ = 69.54 $n_{.2}$ = 22	$\bar{X}_{.3}$ = 73.09 $n_{.3}$ = 22	$\bar{X}_{.4}$ = 77.41 $n_{.4}$ = 22	$\bar{X}_{T}$ = 74.14 N = 88

Over-all Performance and
Rate of Forgetting

Over-all performance is defined as the score obtained when the scores made on the two posttests by a student in the experiment are summed. Rate of forgetting is defined as the change over time in the scores made on the immediate posttest and the score made on the same posttest administered after a delay of two weeks.

The effectiveness of the four instructional methods on student over-all performance and rate of forgetting was studied using a repeated measures analysis. The findings relative to over-all performance and rate of forgetting pertain to the last three research hypotheses.

Research Hypothesis 7: The four treatments have differential effects on the over-all performance of students.

Research Hypothesis 8: The four treatments result in different rates of forgetting.

Research Hypothesis 9: The differences in over-all performance scores resulting from the four treatments are not identically reflected at each ability level.

A summary of the results of the repeated measures analysis of immediate and delayed posttests scores is shown in Table III. The F ratio observed for treatment effect was 0.37 . The critical value of F at 3,76 df and 0.05 level of

TABLE III

SUMMARY OF REPEATED MEASURES ANALYSIS

Source of Variation	df	SS	MS	F
Between Subjects	87			
Levels	2	32,147.89	16,073.95	--
Treatments	3	939.29	313.10	.37 ns
Interaction: (Level x Treatment)	6	1,426.14	2,139.21	2.50*
Subj w. groups	76	64,974.23	854.92	
Within Subjects	88			
Posttests	1	22.55	22.55	--
Interaction: (Level x Posttests)	2	417.67	835.34	5.44*
Interaction: (Treatment x Posttests)	3	366.70	1,100.09	7.16*
Interaction: (Level x Treatment x Posttest)	6	332.20	1,993.22	12.98*
Posttests x subj w. groups	76	11,669.38	153.54	
Total	175	112,296.05		

*p < .05

significance was 2.73 . Hence, the null hypothesis for Research Hypothesis #7 was retained. The F ratio observed for treatment-by-posttest interaction effect was 7.16 . Since the critical value of F at 3,76 df and 0.05 level of significance is 2.72, the null hypothesis for Research Hypothesis #8 was rejected. The fact that there was a statistically significant treatment-by-posttests interaction indicated that the slopes of the retention curves for the treatment groups were different. In order to determine which treatments resulted in the least rate of forgetting, the slopes of the retention curves were plotted as shown in Figure 1 based upon the data in Table IV. The retention curve of the control treatment CON had a negative slope, while the retention curve of treatment HIER had a slope which approached a value of zero and the retention curve of treatment OBJ had a positive slope.

TABLE IV

TREATMENT MEANS FOR POSTTESTS

	Immediate	Delayed
Treatment CON	76.50	72.95
Treatment OBJ	69.55	73.50
Treatment B-E	73.09	70.50
Treatment HIER	77.50	76.80

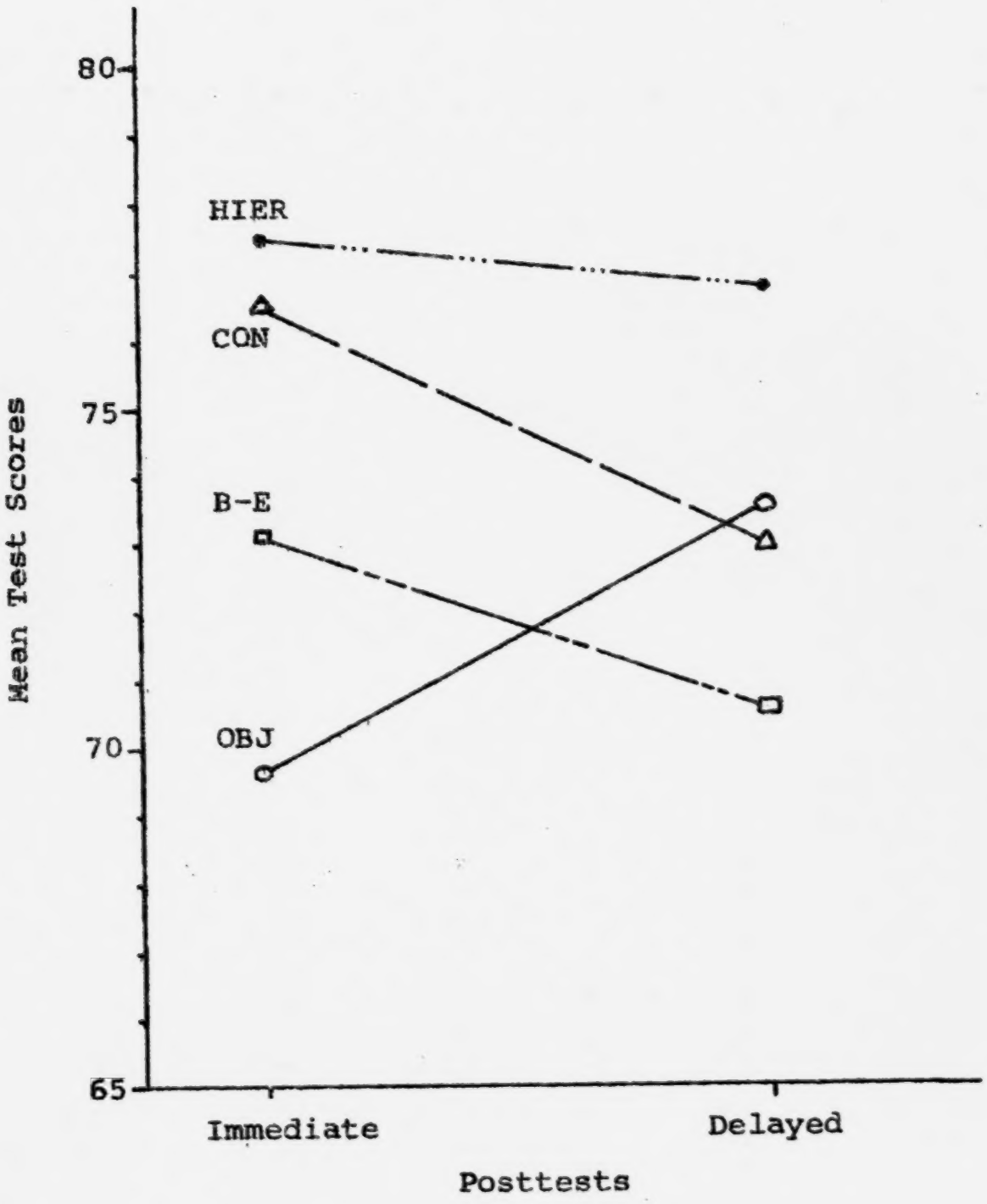

FIGURE 1

RETENTION CURVES

The F ratio observed for level-by-treatment effect was 2.50 . The critical value of F at 6,76 df and 0.05 level of significance is 2.23 . Therefore, the null hypothesis for Research Hypothesis #9 was rejected. The level-by-treatment interaction profiles are shown in Figure 2. The profiles are based upon the data in Table V. The mean of the middle ability students in treatment HIER was 87.14 while the mean of the middle ability students across all four treatments was 81.01 . The means of the other two ability groups in treatment HIER did not show as much difference between their respective means and their means across the four treatments.

TABLE V

ABILITY LEVEL OVER-ALL PERFORMANCE MEANS FOR TREATMENTS

Ability Levels	Treatments			
	CON	OBJ	B-E	HIER
High	94.25	86.75	94.50	94.00
Medium	82.11	81.44	73.33	87.17
Low	58.67	54.83	60.00	59.66

Table VI presents the standard deviation and the cell and marginal means for the immediate posttest and the delayed posttest scores analyzed in the repeated measures analysis.

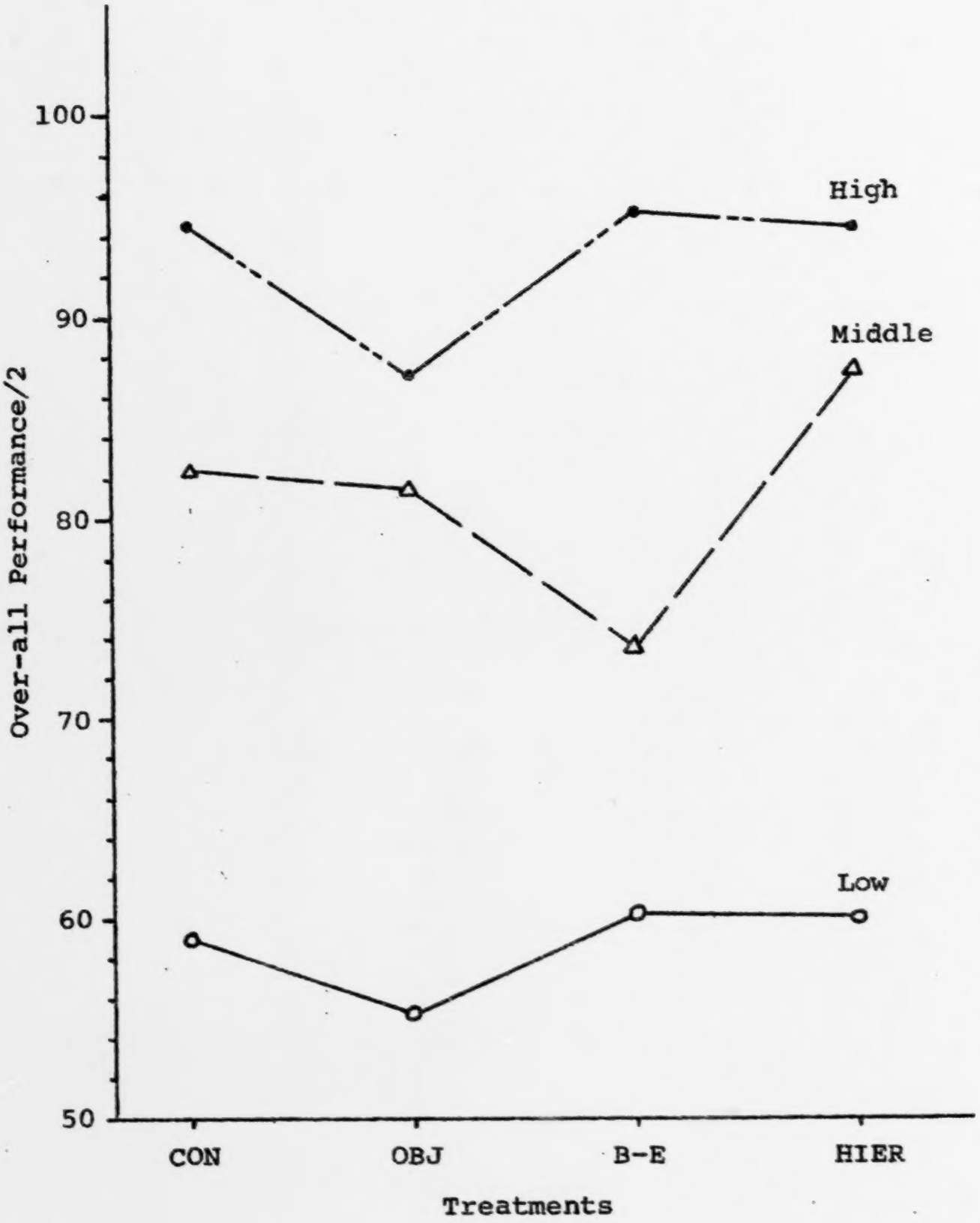

FIGURE 2

LEVEL x TREATMENT INTERACTION PROFILES

TABLE VI

MEANS, CELL SIZES, AND STANDARD DEVIATIONS
OF IMMEDIATE AND DELAYED POSTTEST SCORES

Treatments	Levels of Ability	Posttests: Immediate	Posttests: Delayed	
CON	H1	$\bar{X}_{111}$ = 95.50 SD_{111} = 3.00 n_{111} = 4	$\bar{X}_{112}$ = 93.00 SD_{112} = 8.08 n_{112} = 4	$\bar{X}_{11.}$ = 94.25
	M1	$\bar{X}_{121}$ = 82.00 SD_{121} = 14.11 n_{121} = 9	82.22 14.16 9	$\bar{X}_{12.}$ = 82.11
	L1	62.56 26.81 9	54.77 24.94 9	$\bar{X}_{13.}$ = 58.67
OBJ	H2	86.50 17.99 4	87.00 9.87 4	$\bar{X}_{21.}$ = 86.75
	M2	78.44 11.74 9	84.44 15.90 9	$\bar{X}_{22.}$ = 81.44
	L2	53.11 31.52 9	56.56 21.28 9	$\bar{X}_{23.}$ = 54.83

TABLE VI (continued)

Treatments	Levels of Ability	Posttests: Immediate	Posttests: Delayed	
B-E	H3	$\bar{X}_{131}$ = 95.00 SD_{131} = 10.00 n_{131} = 4	$\bar{X}_{132}$ = 94.00 SD_{132} = 8.49 n_{132} = 4	$\bar{X}_{31.}$ = 94.50
	M3	74.44 23.60 9	72.56 25.06 9	$\bar{X}_{32.}$ = 73.33
	L3	62.00 32.44 9	58.00 35.44 9	$\bar{X}_{33.}$ = 60.00
HIER	H4	91.00 18.00 4	97.00 3.47 4	$\bar{X}_{41.}$ = 94.00
	M4	84.56 16.85 9	89.56 18.78 9	$\bar{X}_{42.}$ = 87.17
	L4	64.23 23.14 9	55.11 30.92 9	$\bar{X}_{43.}$ = 59.66
		$\bar{X}_{..1}$ = 74.14	$\bar{X}_{..2}$ = 73.44	$\bar{X}_{T}$ = 73.80

Conclusions

Of the nine hypotheses formulated, two were supported by the data. The expectations pertaining to achievement differences expressed in the first six research hypotheses are not supported by the data. Likewise, the seventh research hypothesis that the four treatments have differential effects on the over-all performance of students is not supported by the data.

However, the following conclusions hold for research hypotheses #8 and #9:

> #8 The hypothesis that the four treatments result in <u>different rates of forgetting</u> is supported by the data.
>
> #9 The hypothesis that the differences in over-all performance scores resulting from the four treatments are not identically reflected at each ability level is supported by the data.

Discussion

<u>Immediate Achievement</u>. The results of the study appeared to be quite conclusive in terms of there being no observable differential effects of the four treatments on immediate achievement scores. The analysis of the data provided no support for qualifying this finding on the basis of ability levels.

Over-all Performance and Rate of Forgetting. The results of the study indicated that if the levels of ability of students are not considered, then the benefits in terms of over-all performance to be derived from either of the four treatments do not differ significantly at the 0.05 level. However, the presence of the significant treatments-by-levels interaction effect found in the study indicate that differences between the effects of the four treatments do exist within the three levels of ability. Therefore, any predictive statement concerning the effects of the four treatments on over-all performance must be qualified by specifying the levels of ability involved.

The observed treatments-by-levels profiles reveal that giving students statements of the behavioral objectives of an activity accompanied by a copy of the learning hierarchy is more beneficial in terms of over-all performance (when compared to the other three treatments) to the students in the middle ability level than to those students in either the high or the low ability levels. It is reasonable to argue from this finding that the low ability level students were not able to assimilate the additional information and, thus, received no benefit from being given the objectives and/or the learning hierarchy. From the treatments-by-levels profiles, one might project that the

additional information about objectives actually confused the low ability level students. The students in the high ability level group apparently received no differential benefit from either of the treatments. One might argue in this case that the pre-organizing benefit possibly provided by the statements of the behavioral objectives and/or learning hierarchy were not needed. Perhaps the high level students were able to infer the objectives and the learning sequence itself. In the case of the middle ability group, one could assert that the objective statements accompanied by the learning hierarchy enabled them to gain a helpful perspective about the mathematical skill which they were expected to learn.

The significant treatment-by-posttest interaction effects found by the repeated measure analysis is a second indication that differences in the four treatments do exist. This interaction effect revealed that the <u>treatments result in different rates of forgetting</u>. The more striking difference observed is that while the rate of forgetting of treatments CON and B-E show a negative gain and the rate of forgetting of treatment HIER showed neither gain nor loss of the mathematical skill, the slope of the treatment OBJ retention curve showed a positive gain. The findings of this study reveal that while giving students statements of

the behavioral objectives of each activity of the instruction unit (OBJ) did not result in relatively higher immediate achievement scores, the treatment did result in greater resistance to forgetting than the other methods of instruction. One could reasonably argue that the students who were informed of the behavioral objectives were able to gain in ability to perform the terminal task because the combination of being aware of the behavioral objectives and the two-week period between posttests resulted in their being able to better assimilate the instructional material they had received.

There may be several reasons that the findings of this study lend no support to the assertion that telling students the behavioral objectives and/or the learning hierarchy of a unit of instruction will increase their performance on immediate achievement tests. The author believes that an important reason that the data of the study did not support the immediate achievement expectations was that single-medium self-instructional materials were used. One might question whether supportive data would be obtained from a similar study conducted in a typical classroom situation without the use of self-instructional materials. The author is presently preparing to conduct such a study in a county school system in Maryland.

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